



## Features

- Dual axis measurement with  $\pm 30^\circ$  range
- High resolution and accuracy
- Low temperature drift
- Serial RS232 interface
- Tough sealed anodised aluminium housing (IP67)
- CE certified and RoHS compliant
- Braided screen 3m PUR cable with 4 pole M8 female connector
- Low cost relative to performance
- Small size, 75 x 37.5 x 15mm and light weight



## Description

The SOLAR-2-30-1-RS232-03 inclinometer is a high performance low cost dual axis tilt sensor for measurement of angle in both the pitch and roll axes. This specific part number includes an M8 4-pole female connector which allows it to plug directly into the IDS display system (please see our website for further details). The housing is a small, low profile Aluminium housing, hermetically sealed to IP67. The cable is a shielded black PUR cable which is suitable for continuous outdoor use. They utilise a very high performance MEMS

sensor which exhibits low long term drift compared with many competitive devices. It has an RS232 interface and uses our standard communication protocol. They are CE and RoHS certified, and are manufactured, calibrated and individually tested in our UK factory to guarantee performance to the stated specification. This version is calibrated and tested at  $\pm 30^\circ$  and it is not temperature compensated, however we also offer several other standard options from  $\pm 5^\circ$  to  $\pm 45^\circ$  and without a connector, see page 5 for details.

## General Specifications

Parameter	Value	Unit	Notes
<b>Supply Voltage</b>	9-30	V dc	Supply is filtered, suppressed and regulated internally, however we recommend the use of a low noise supply to prevent noise coupling to the sensor.
<b>Operating Current</b>	30mA (@ 9V) 20mA (@ 12V) 10.5mA (@ 24V)	mA	Supply current depends on supply voltage.
<b>Operating Temperature</b>	-40 to 85	$^\circ\text{C}$	Maximum operating temperature range. Units can be calibrated between -20 and $70^\circ\text{C}$ on request.
<b>RS232 Output Rate</b>	38400	bps	Bit rate is adjustable between 115.2k, 57.6k, 38.4k, 19.2k, 9.6k, 4.8k and 2.4k via the digital interface
<b>RS232 Data Format</b>	38.4, 8,1,N		1 start bit, 8 data bits, 1 stop bit, no parity
<b>Frequency Response</b>	1	Hz	This is the frequency at which the output is 3dB less than the input value, adjustable between 16Hz & 0.125Hz via the RS232 control commands
<b>Mechanical shock</b>	5000	G	Shock survival limit for internal sensor 5000G for 0.5ms
<b>Weight</b>	45	g	Not including cable
<b>Cable</b>	3	m	4 Core braided screen cable with black PUR jacket
<b>Sealing</b>	IP67	-	Seal rating applies to housing and cable gland. Gland is not designed for flexible cable installation, as this may compromise seal rating



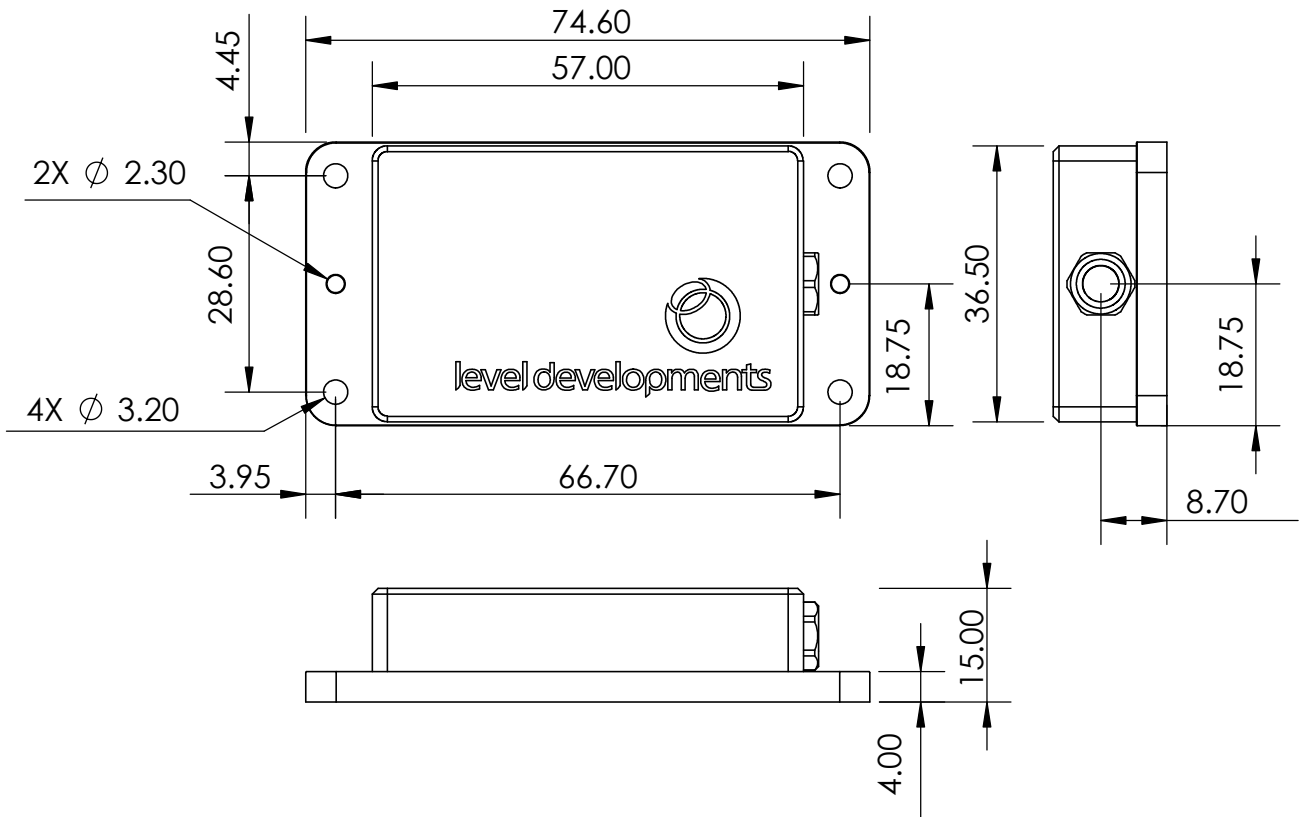
## Performance Specifications

Parameter	SOLAR-30	Unit
Measuring range	±30	°
Zero Bias Error	±0.015	°
Accuracy (@20°C)	±0.030	°
Temperature Errors		
Zero Drift	±0.0015	°/°C
Sensitivity Drift	±0.0030	%/°C
Accuracy -10 to 60°C	±0.120	°
Long Term Stability	±0.007	°
Resolution (@1Hz BW)	0.001	°

Parameter	Notes
Measuring range	Defines the calibrated measurement range. Direction of measurement can be reversed and zero position can be reset anywhere in range. Settings are stored in non volatile memory so are remembered after power down.
Zero Bias Error	This is the <b>maximum</b> angle from the device when it is placed on a perfectly level surface. The zero bias error can be removed from measurement errors either by mechanical adjustment, or as a fixed offset value after installation, or by using the 'setzcur' command to zero the device (see page 8)
Accuracy (@20°C)	This is the <b>maximum</b> error between the measured and displayed value at any point in the measurement range when the device is at room temperature (20°C). This value includes cross axis errors.
Temperature Errors	These figures are for devices without additional temperature compensation. See part numbering options on page 7 for further details.
Zero Drift	If the device is mounted to a level surface in the zero position, this value is the <b>maximum</b> drift of the output angle per °C change in temperature.
Sensitivity Drift	When the temperature changes there is a change in sensitivity of the sensor's output. The error this causes in the measurement is calculated from the formula: <b><math>E_{sd} = SD \times \Delta T \times \theta</math></b> Where: <b><math>E_{sd}</math></b> is the change in output (in degrees) due to sensitivity temperature change <b><math>SD</math></b> is the sensitivity drift specification from the above table (0.003%) <b><math>\Delta T</math></b> is the change in temperature in °C <b><math>\theta</math></b> is the current angle of the inclinometer axis in question in degrees.
Accuracy -10 to 60°C	This is the <b>maximum</b> error between the measured and displayed value at any point in the measurement range at any temperature over the specified temperature range without individual temperature compensation.
Long Term Stability	Stability depends on environment (temperature, shock, vibration and power supply). This figure is based on being powered continuously in an ideal environment.
Resolution (@1Hz bandwidth)	Resolution is the smallest measurable change in output.

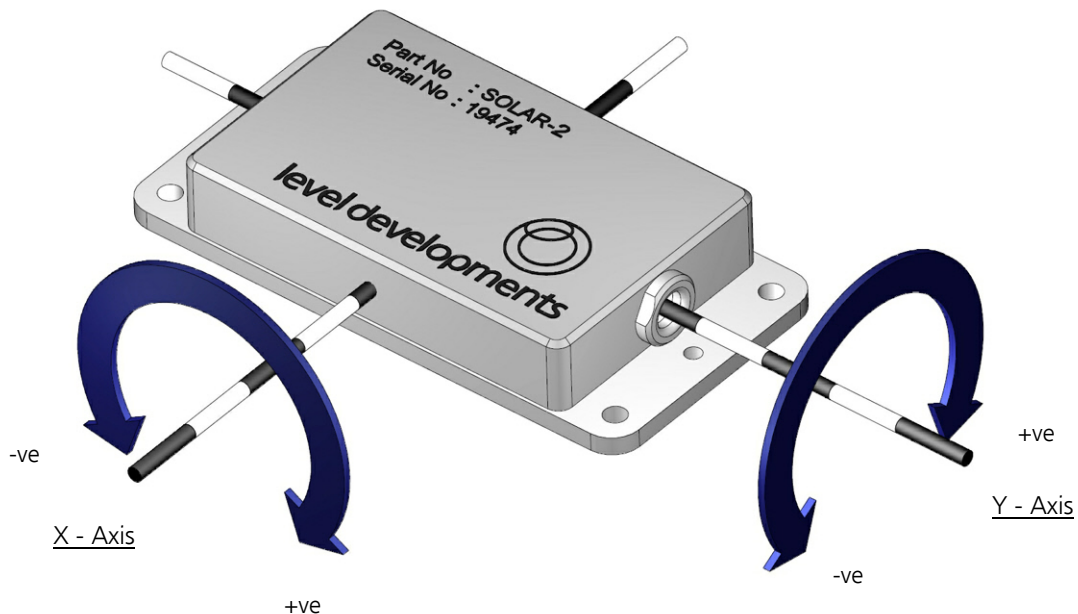


Housing Drawing



Axis Direction and Mounting Orientation and Wiring Details

Mounted on a Horizontal Surface



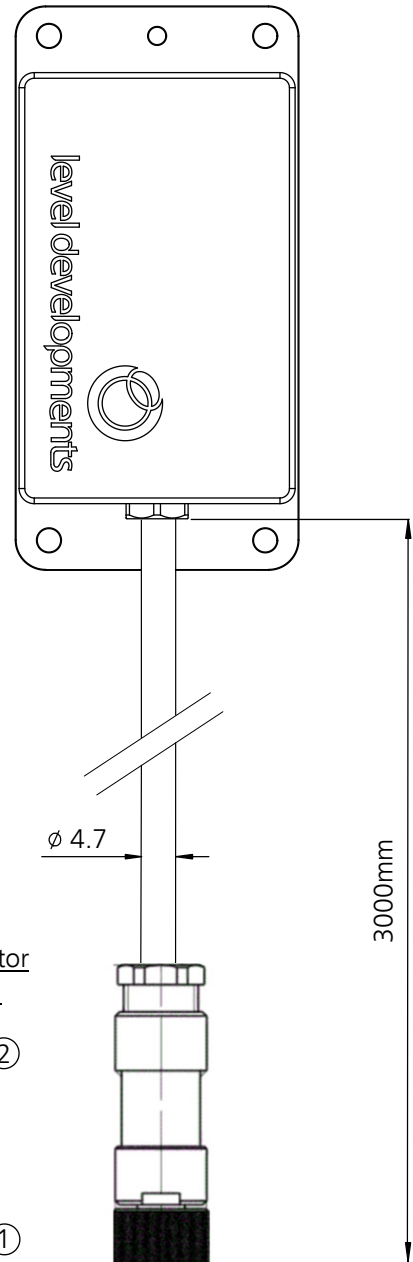


Cable and Connector Details

Parameter	Value
Connector description	M8 4-pin female
Overall length	3 meters
Connector seal rating	IP67
Braided	Yes
Braid type	Tin plated Copper
Jacket material	PUR
Jacket diameter	4.7mm (max)
Wire Gauge	24 AWG
Conductor strands	41x0.08mm



Pin Number	Function
1	+12v Supply
2	Ground
3	RS232 Rxd
4	RS232 Txd



Certification

The products are type approved to in accordance with the following directive(s):

EMC Directive 2004/108/EC

And it has been designed, manufactured and tested to the following specifications:

BS EN61326-1:2006

Electrical equipment for measurement, control and laboratory use – EMC Requirements

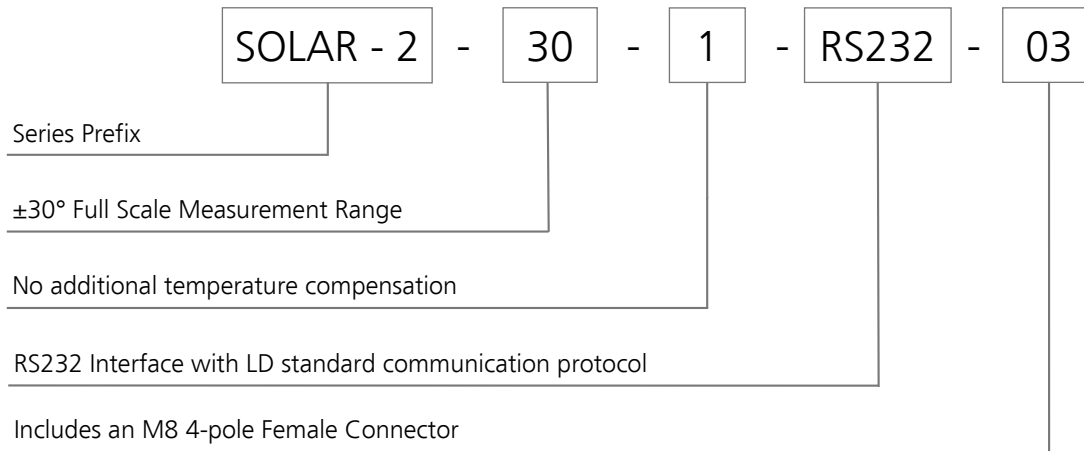
BS EN55011:2007, Group 1 Class B

Certification is available on request.





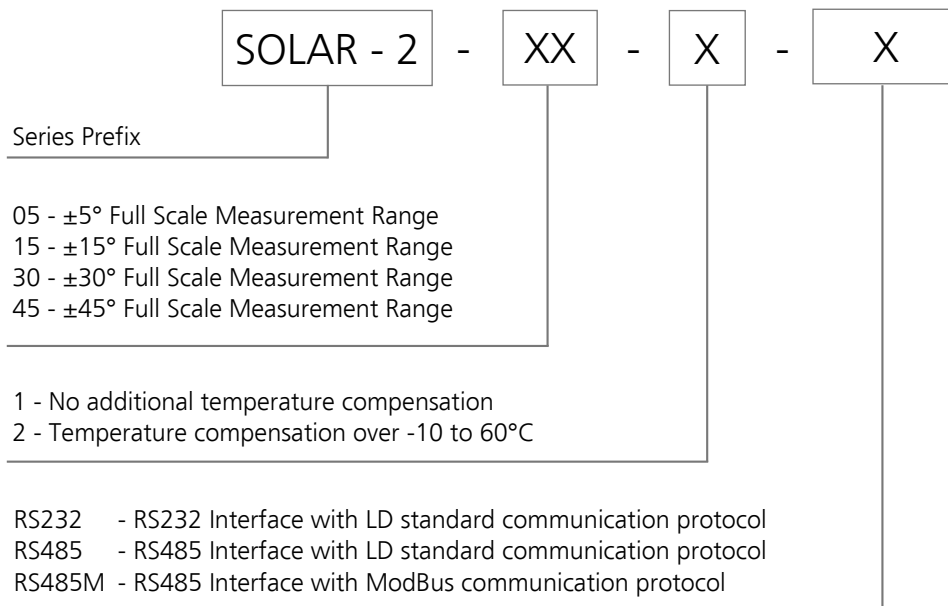
SOLAR-2-30-1-RS232-03 Part Number Details



Please Note:

- The SOLAR-2-30-1-RS232-03 is supplied with an M8 4-Pole Female connector fitted to the cable, it is compatible with the IDS display:  
<https://www.leveldevelopments.com/products/inclinometers/digital-inclinometers/ids-oled-inclinometer-display-system/>
- "03" cannot simply be added to other/standard parts to receive a connector, please ask for details if unsure.

Other Standard Part Numbering



Please Note:

- Standard options are not supplied with a connector attached, they are supplied with bare ended wires, see the standard version datasheet for more details:  
[https://www.leveldevelopments.com/wp/wp-content/uploads/documents/SOLAR-2\\_Dual\\_Axis\\_Inclinometer.pdf](https://www.leveldevelopments.com/wp/wp-content/uploads/documents/SOLAR-2_Dual_Axis_Inclinometer.pdf)
- (However) if one of these standard options are purchased at the same time as an IDS display, an M8 connector will be fitted to the sensor free of charge.
- Only RS232 models are compatible with the IDS display, do not attempt to connect an RS485 or RS485M model to the IDS Display.



**Level Developments Simplified Control Command Set**

Data is transmitted and received over RS232 in full duplex mode. The default configuration is with the baud rate set to 38.4kbps, with 8 data bits, 1 stop bit and no parity. All commands are lower case and 7 bytes long. The time between each character of the command must be less than 100ms otherwise the device will discard the command. The settings are all stored in non volatile memory.

Command	Description	Response Length	Response
get---x	Returns the X axis angle as either: - An INT32 value equal to the angle x 1000 - A fixed length ASCII string terminated with a carriage return depending on the setting of commands 'setoasc' or 'setoint' Shipping default is INT32.	4 bytes 9 bytes	0x XX XX XX XX +025.430<CR>
get---y	Returns the Y axis angle as either: - An INT32 value equal to the angle x 1000 - A fixed length ASCII string terminated with a carriage return depending on the setting of commands 'setoasc' or 'setoint' Shipping default is INT32.	4 bytes 9 bytes	0x YY YY YY YY +025.430<CR>
get-x&y	Returns the X and Y axis angle (X is transmitted first) as either: - A pair of INT32 value equal to the angle x 1000 - A fixed length comma separated ASCII string terminated with <CR> depending on the setting of commands 'setoasc' or 'setoint' Shipping default is INT32.	8 bytes 18 bytes	0x XX XX XX XX YY YY YY YY ±xxx.xxx,±yyy.yyy<CR>
gettemp	Returns the temperature of the sensor as either: - An INT16 value equal to the temperature x 100 - A fixed length ASCII string terminated with a carriage return depending on the setting of commands 'setoasc' or 'setoint' Shipping default is INT32.	2 bytes 6 bytes	0x XX XX ±tt.t<CR>
str9999	Set continuous output transmission rate in milliseconds (25-9999ms) - str0100 - 100ms (0.1s) between transmissions	2 bytes	OK
setcasc	Sets the output to transmit the X and Y angle continuously in ASCII format at the rate defined by strXXXX.	18 bytes	±xxx.xxx,±yyy.yyy<CR>
stpcasc	Stops the continuous transmission of ASCII data	2 bytes	OK
get-flt	Returns the value of the current filter time constant in ms as an INT16	2 bytes	0x XX XX
setdir1 setdir2 setdir3 setdir4	Sets the X axis measurement direction to positive clockwise Sets the X axis measurement direction to negative clockwise Sets the Y axis measurement direction to positive clockwise Sets the Y axis measurement direction to negative clockwise	2 bytes	OK
setzcur	Tare function to set the current position to zero	2 bytes	OK
setzfac	Cancels tare function and resets zero to factory setting	2 bytes	OK
setoasc	Sets the output to ASCII format	2 bytes	OK
setoint	Sets the output to Integer format	2 bytes	OK
setflt1 setflt2 setflt3 setflt4 setflt5 setflt6 setflt7 setflt8	Sets the digital filter frequency response to 0.125Hz Sets the digital filter frequency response to 0.25Hz Sets the digital filter frequency response to 0.5Hz Sets the digital filter frequency response to 1Hz Sets the digital filter frequency response to 2Hz Sets the digital filter frequency response to 4Hz Sets the digital filter frequency response to 8Hz Sets the digital filter frequency response to 16Hz	2 bytes	OK
set-br1 set-br2 set-br3 set-br4 set-br5 set-br6 set-br7	Sets the BAUD rate to 2400bps Sets the BAUD rate to 4800bps Sets the BAUD rate to 9600bps Sets the BAUD rate to 19200bps Sets the BAUD rate to 38400bps Sets the BAUD rate to 57600bps Sets the BAUD rate to 115200bps	2 bytes	OK

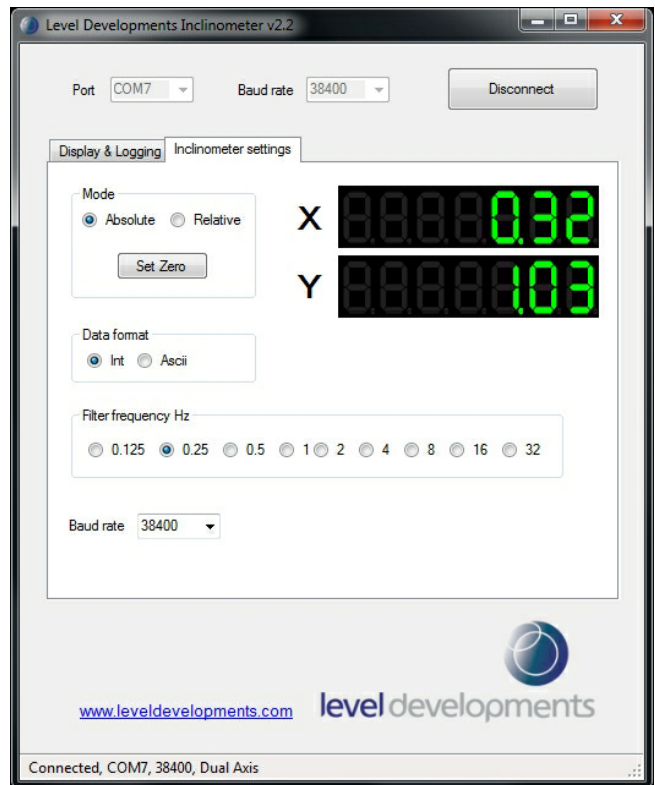
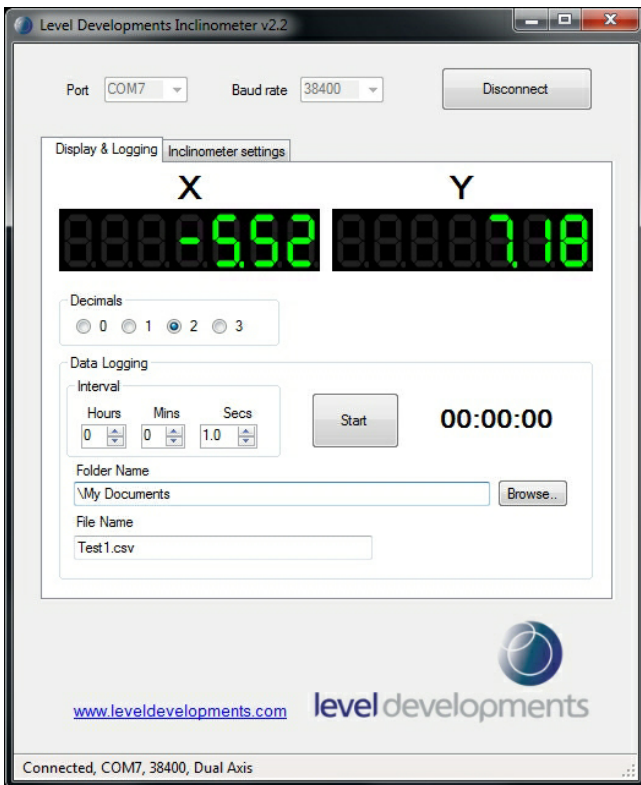


### Software

A free Windows based application for reading angle, logging and device configuration is available from our website. It requires Windows XP SP3, Windows 7 or Windows 8, and works with 32 and 64 bit systems. It also requires the .net framework V3.5 or higher, and will prompt you to download and install this from Microsoft if it is not already installed on your system. A COM port is also required, and can either be a built in COM port, or a USB to Serial COM port.

The basic features are shown below:

- Automatic or manual configuration of COM port parameters
- Compatible with single or dual axis sensors
- Adjustable number of decimal places on displays
- Logging of data at specified intervals into CSV file
- Setting device to absolute or relative measurement mode
- Switching the data transfer protocol between Integer and ASCII
- Changing the frequency response of the sensor
- Changing the Baud rate of the sensor



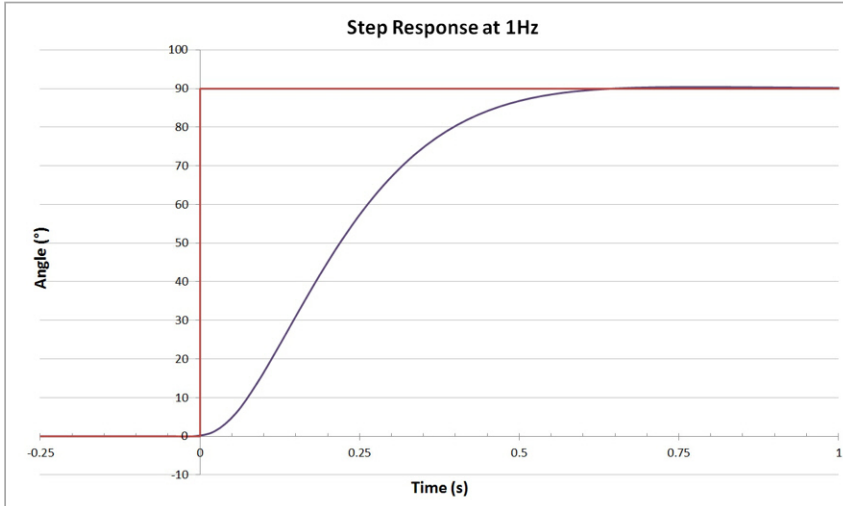
We can also offer custom software development services, please contact us for further information.

**This software is provided 'as-is', without any express or implied warranty. In no event will the authors be held liable for any damages arising from the use of this software.**



### Frequency Response Filter Indexes

The frequency response of the sensor can be changed to any of the response times shown in the table. The filter is a 2nd order Bessel low pass filter implemented in a IIR algorithm.



Filter Index	Freq. Response (Hz)	Damping Time (ms)
1	0.125	8000
2	0.25	4000
3	0.5	2000
4	1	1000
5	2	500
6	4	250
7	8	125
8	16	62.5

### Optional Extension Cables (Not Included)

A selection of optional cables can be used to extend the standard 3 meter cable if required, they are directly compatible with the SOLAR-2-30-1-RS232-03 and IDS display, they lock together using threads (no tools required) to form an IP67 seal. Each cable is made from Black PUR and features an M8, 4-pin male to M8 4-pin female connection. Multiple cables can be joined together. The maximum length of cable that RS232 can transmit over depends on many factors, such as the baud rate, the method of termination, the type of cable, the surrounding electrical noise, and the type of transceiver at the other end of the cable. We have tested this device connected with a serial port of a PC at 9600bps over 100m in a low noise environment. These cables can be found on the "Cables and Connectors" section of our website. <https://www.leveldevelopments.com/products/inclinometers/inclinometer-cables-connectors/>



Straight Male to Female Cable, 2m, PUR  
Part # EL-CAB-M8X4MS-M8X4FS-2



Straight Male to Female Cable, 5m, PUR  
Part # EL-CAB-M8X4MS-M8X4FS-5



Straight Male to Female Cable, 10m, PUR  
Part # EL-CAB-M8X4MS-M8X4FS-10